

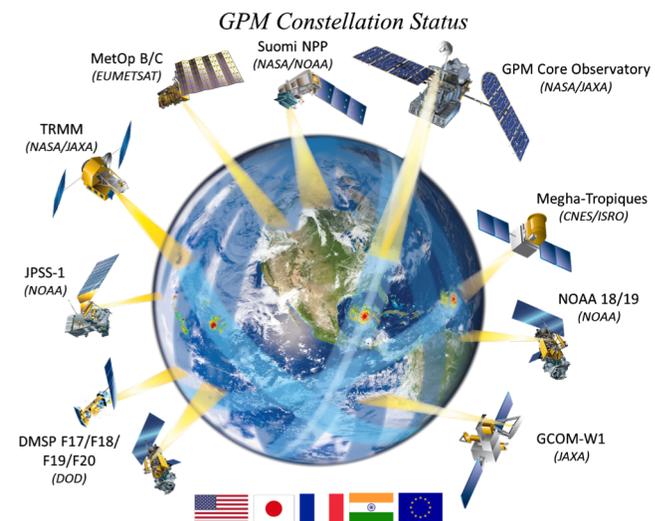
Two Decades of Global Intense Convection in Passive Microwave Observations by Constellation Satellites

– A Perspective from Precipitation Features

Chuntao Liu¹, Nana Liu¹, Daniel Cecil², Edward Zipser³, and Erich Stocker⁴

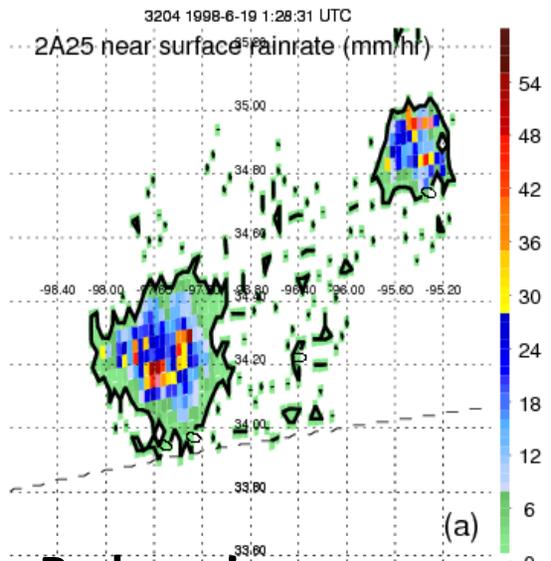
1. Texas A&M –Corpus Christi
2. NASA MSFC
3. University of Utah
4. NASA GSFC

Phoenix, AZ
October, 2018

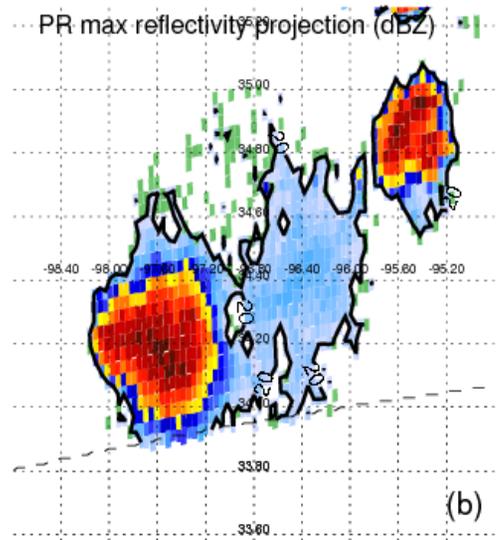


Define precipitation features using TRMM observations

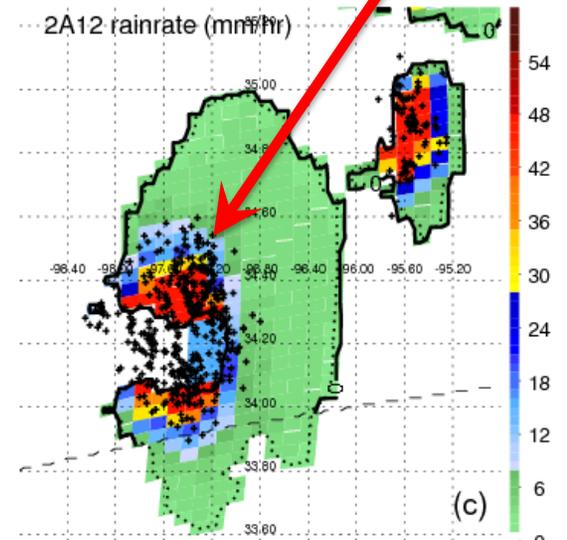
flashes



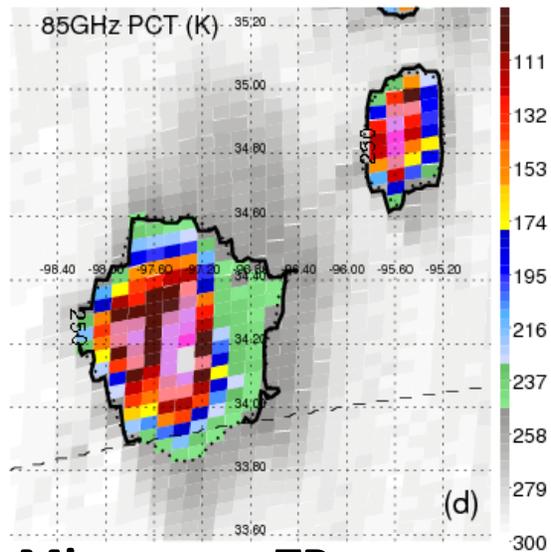
Radar rain



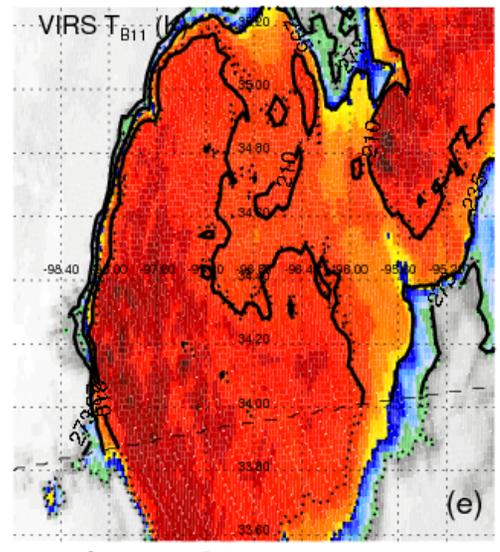
Radar echo aloft



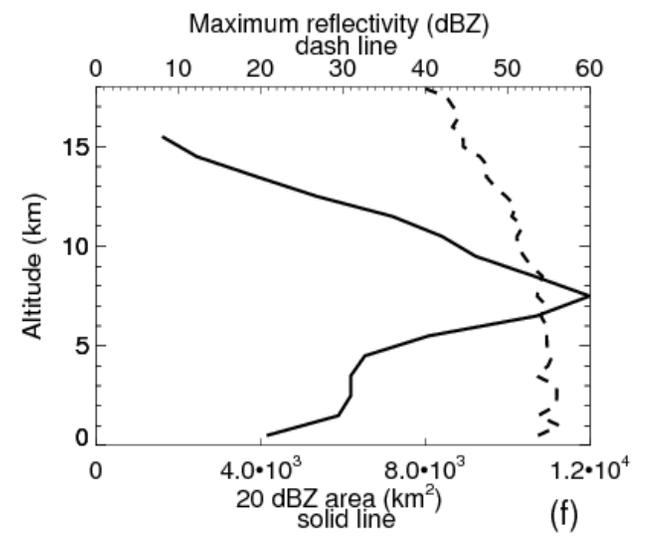
Microwave rain



Microwave TB

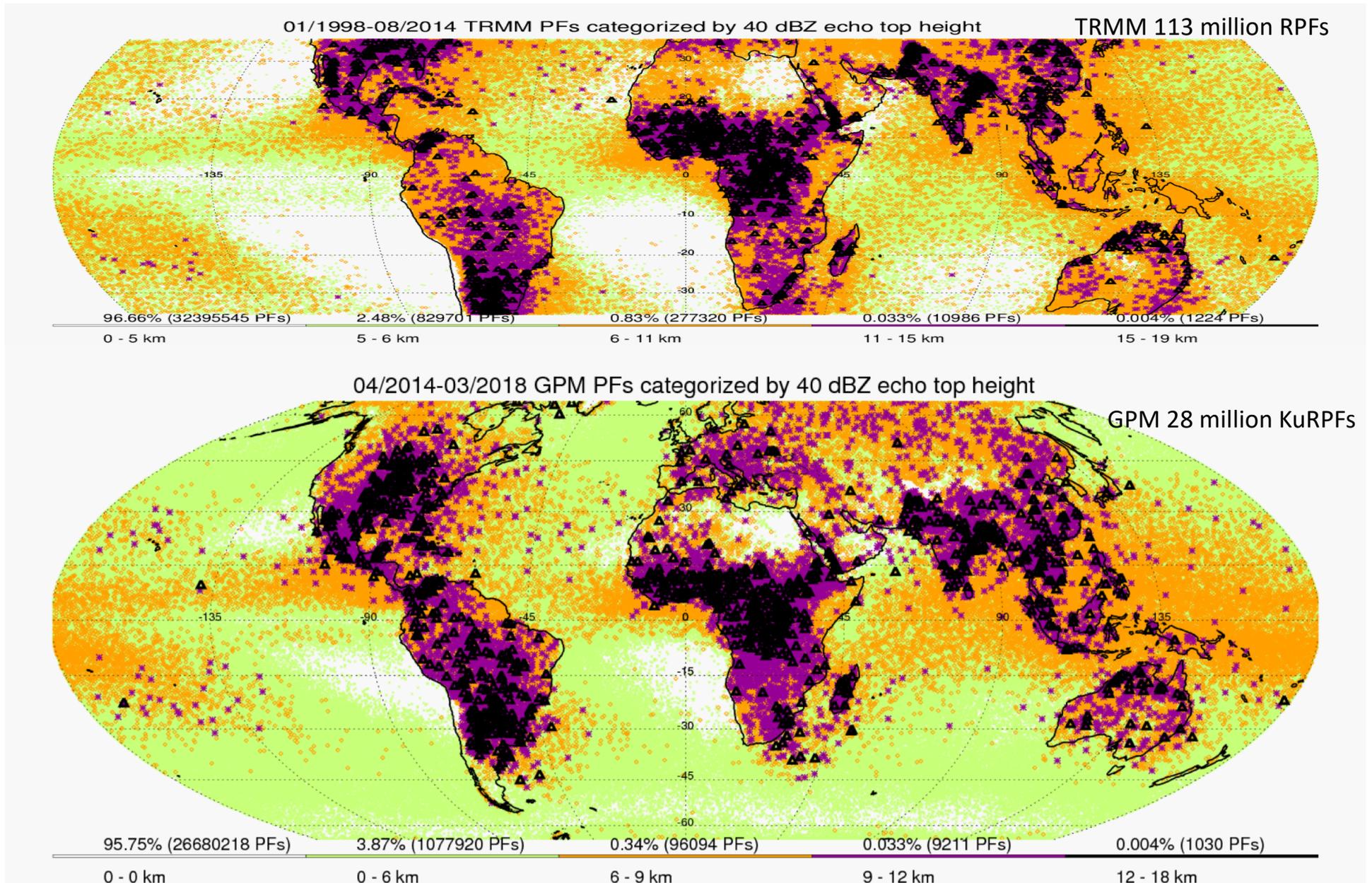


Infrared TB



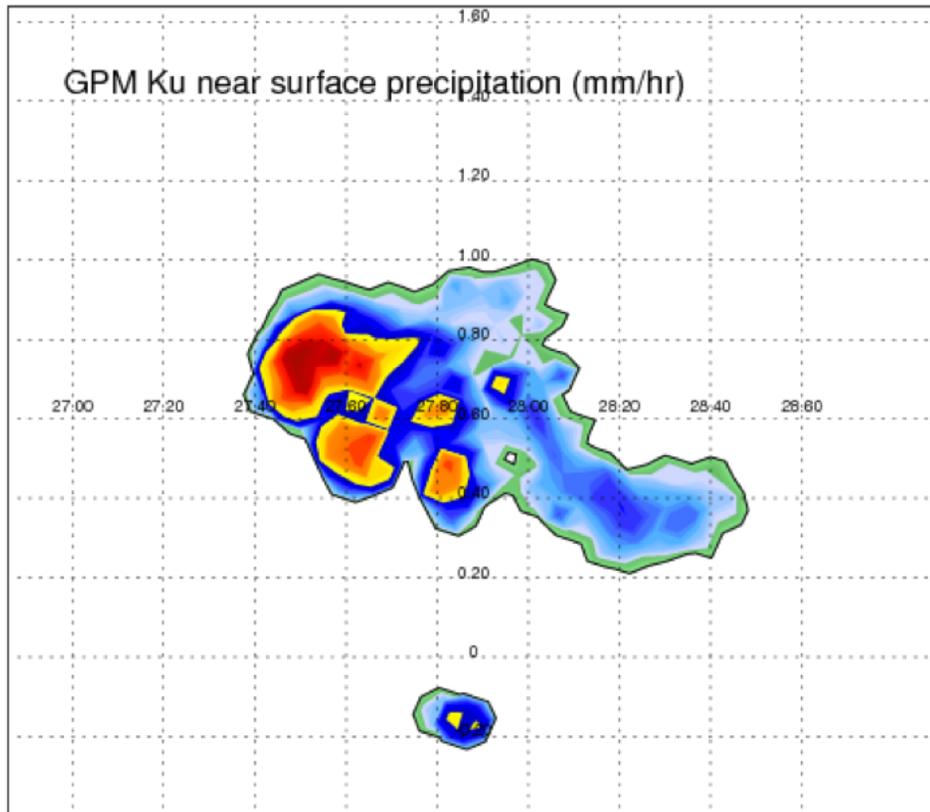
Radar vertical structure

TRMM and GPM Ku radar precipitation features categorized by 40 dBZ echo top height

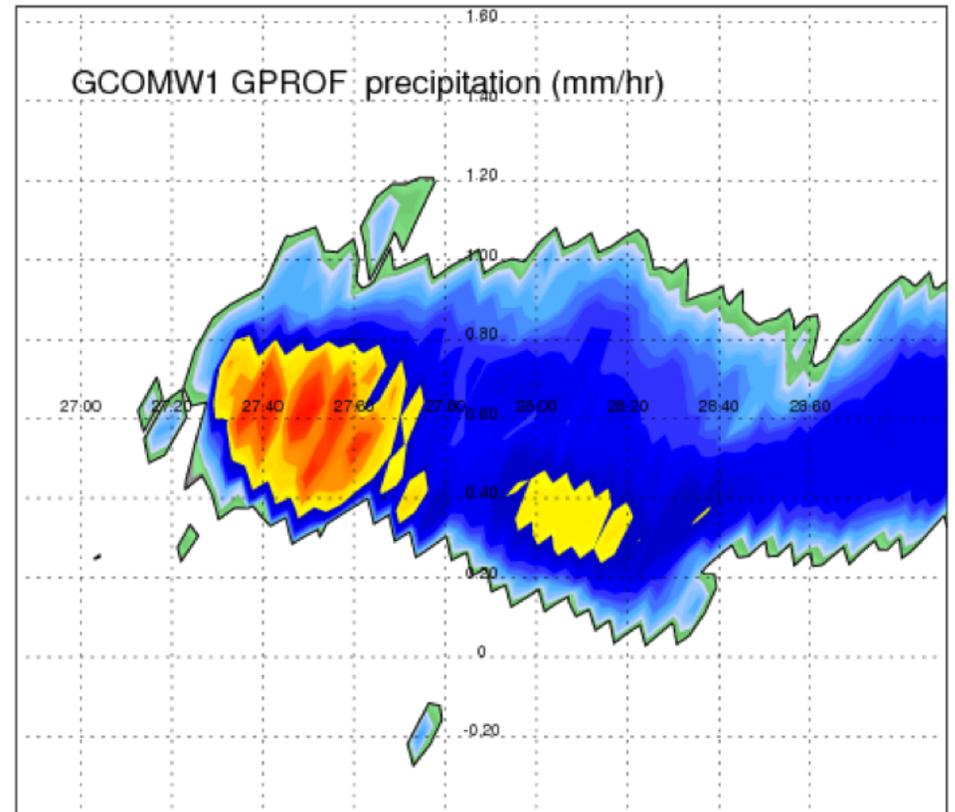


Definition of precipitation features using GPROF and 1C brightness temperatures

GPM orbit: 16807 2017-2-11 23:41



GCOMW1 orbit: 25214 2017-02-12 00:01



Properties of PFs from constellation satellites

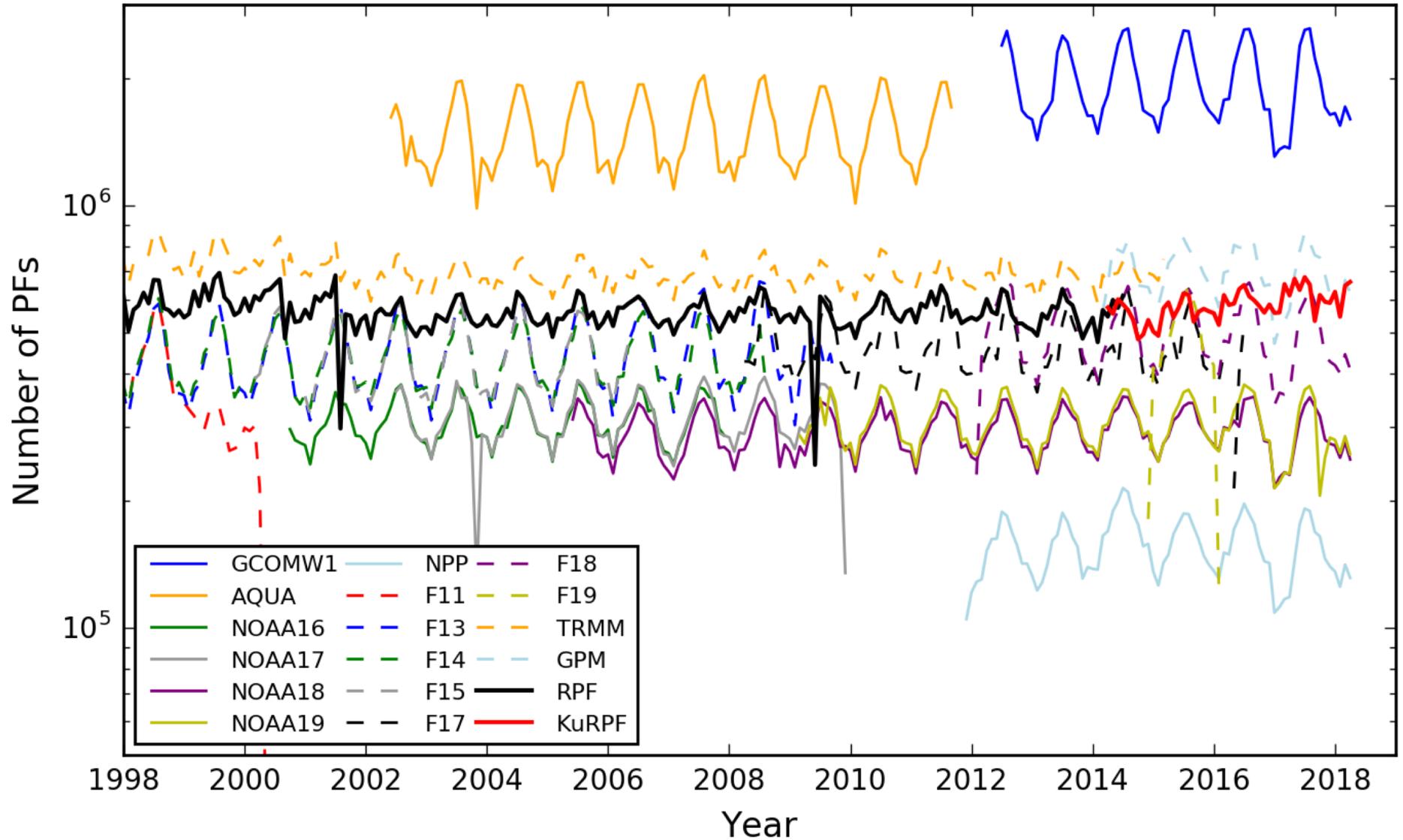
- Input data (Version 5)
 - GPROF precipitation + 1C brightness temperatures
- Definitions
 - Contiguous area with GPROF precipitation
 - Area with 85/89 GHz PCT > 250 K
- Parameters
 - Precipitation area and volume
 - Coldest brightness temperature and cold PCT area
 - Morphology described by ellipse fit

Precipitation features from constellation satellites

Satellite	Sensor	Swath (km)	85-91 GHz Resolution (km)	Periods	PFs (#)
TRMM	TMI	760	11x16 km (85.5 GHz)	1997.12-2015.04	144598515
GPM	GMI	850	5x7 km (85.5 GHz)	2014.03-2018.04	34862569
GCOMW1	AMSR2	1450	3 x5 km (89.0 GHz)	2012.07-2018.04	136816700
AQUA	AMSR-E	1450	4.4 x7.2 km (89.0 GHz)	2002.06-2011.10	167953988
F11	SSM/I	1400	11x16 km (85.5 GHz)	1997.12-2000.05	10434745
F13				1997.12-2009.11	62847019
F14				1997.12-2008.08	56171458
F15				2000.02-2006.08	32338395
F16	SSMIS	1700	13.1 x14.4 km (91 GHz)	2013.12-2017.09	4737995
F17				2008.03-2016.08	45595617
F18				2012.02-2018.04	37325610
F19				2014.12-2016.02	6818591
NPP	ATMS	2200	32 km (89.5 GHz QV)	2011.12-2018.04	11985623
NOAA16	AMSU-B	2250	16 km (89 GHz V)	2000.10-2007.12	26894725
NOAA17				2002.06-2009.12	28119225
METOPA	MHS	2180	16 km (89 GHz V)	2006.12-2018.04	39213270
METOPB				2013.04-2018.04	17610239
NOAA18				2005.05-2018.04	45401589
NOAA19				2009.02-2018.04	3542952

Total ~0.91 billion PFs

PF samples

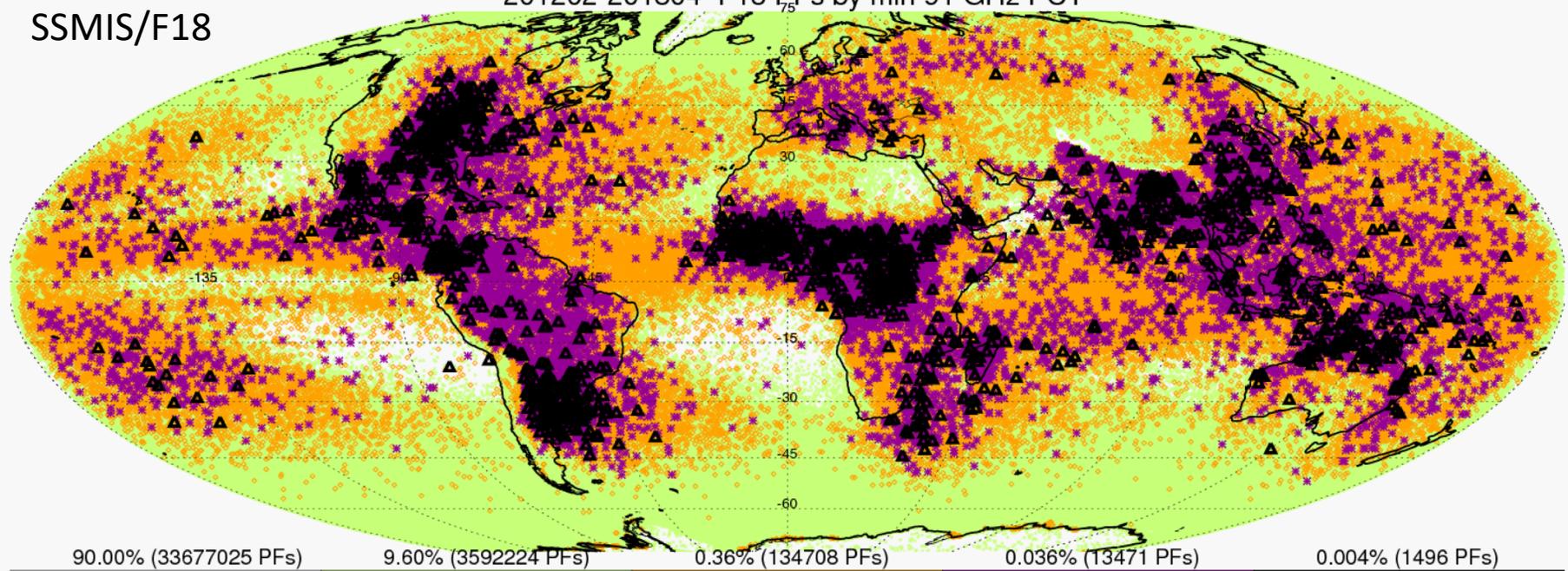


Number of PF samples depends on the resolution and swath width

All PF data are open to public at: <http://atmos.tamucc.edu/trmm/data/>

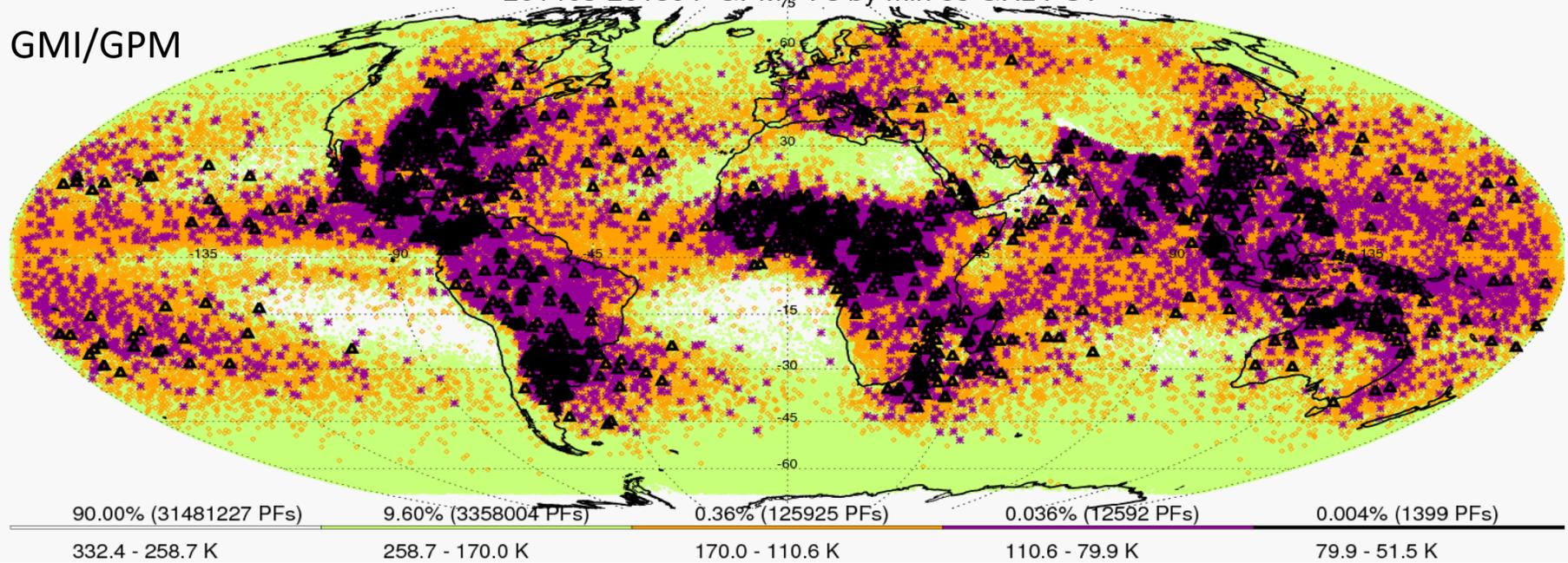
201202-201804 F18 PFs by min 91 GHz PCT

SSMIS/F18



201403-201804 GPM PFs by min 89 GHz PCT

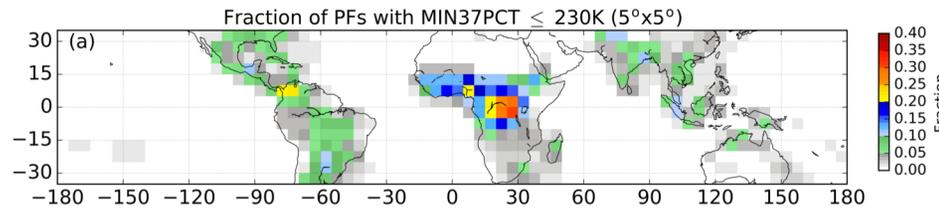
GMI/GPM



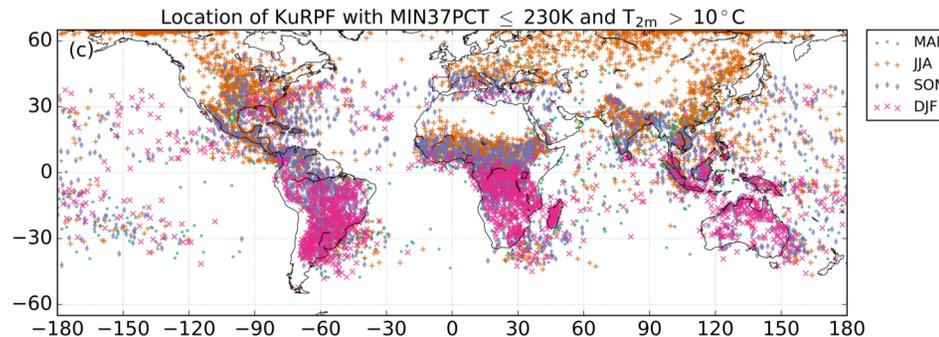
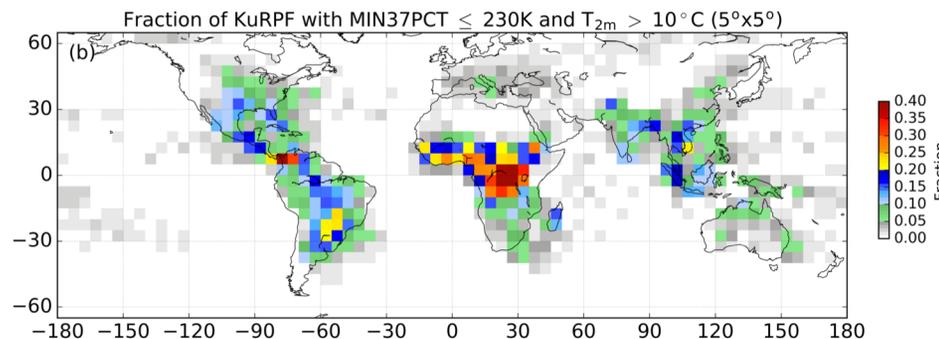
Question: how to intercompare the TBs from different sensors onboard constellation satellites?

37 GHz PCT < 230 K as criteria for ground hail

TRMM



GPM



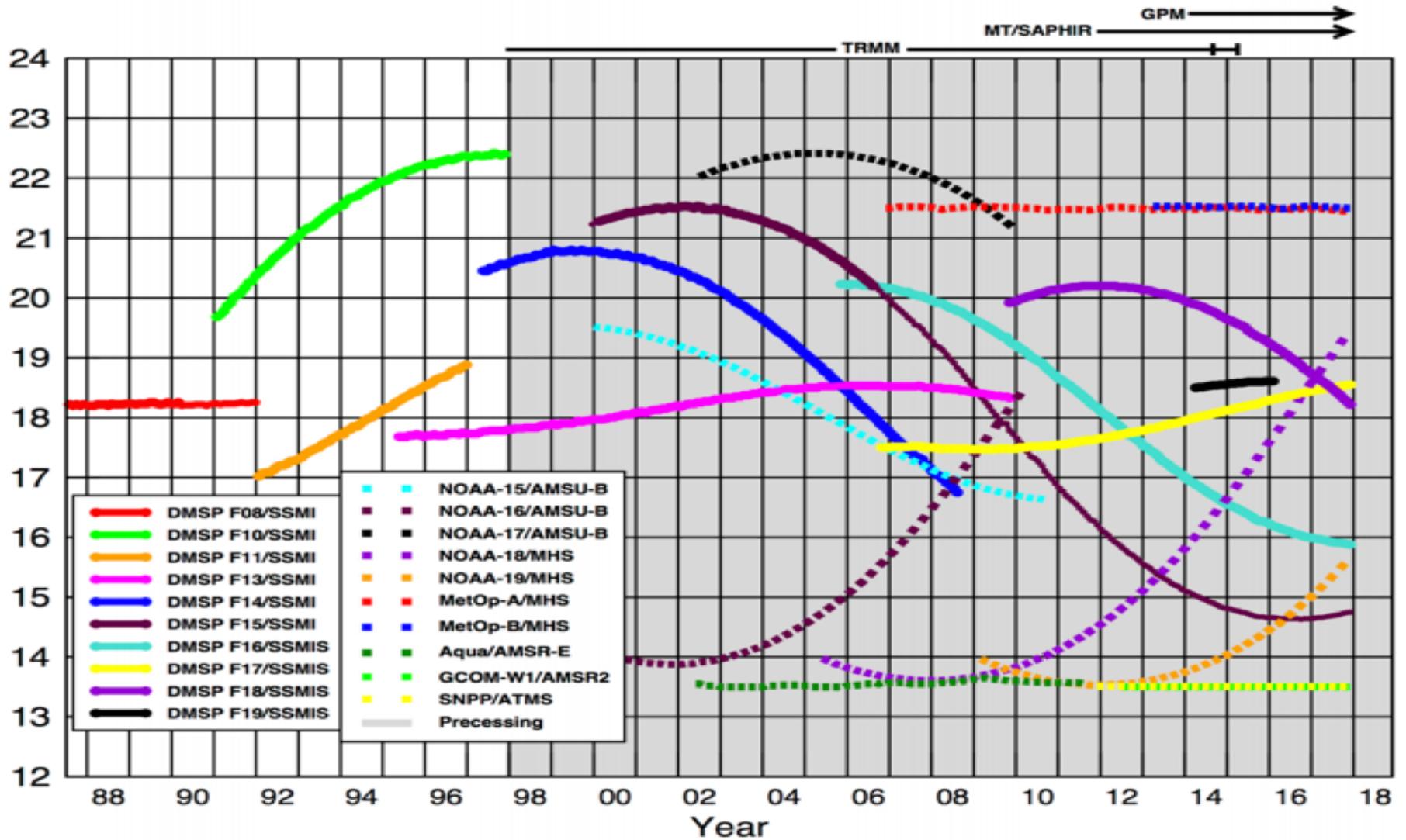
Apply 37 GHz PCT < 230 K to other satellites?

F13, 14, 15, 17, 18, 19, Aqua, GCOMW1, GMI?

Problems:

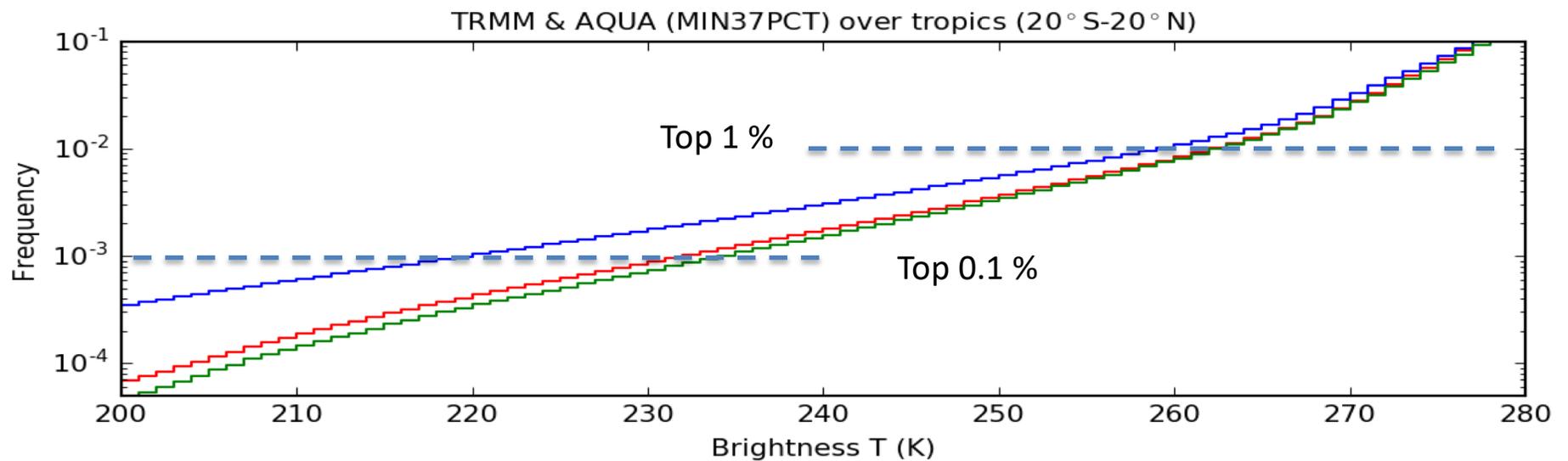
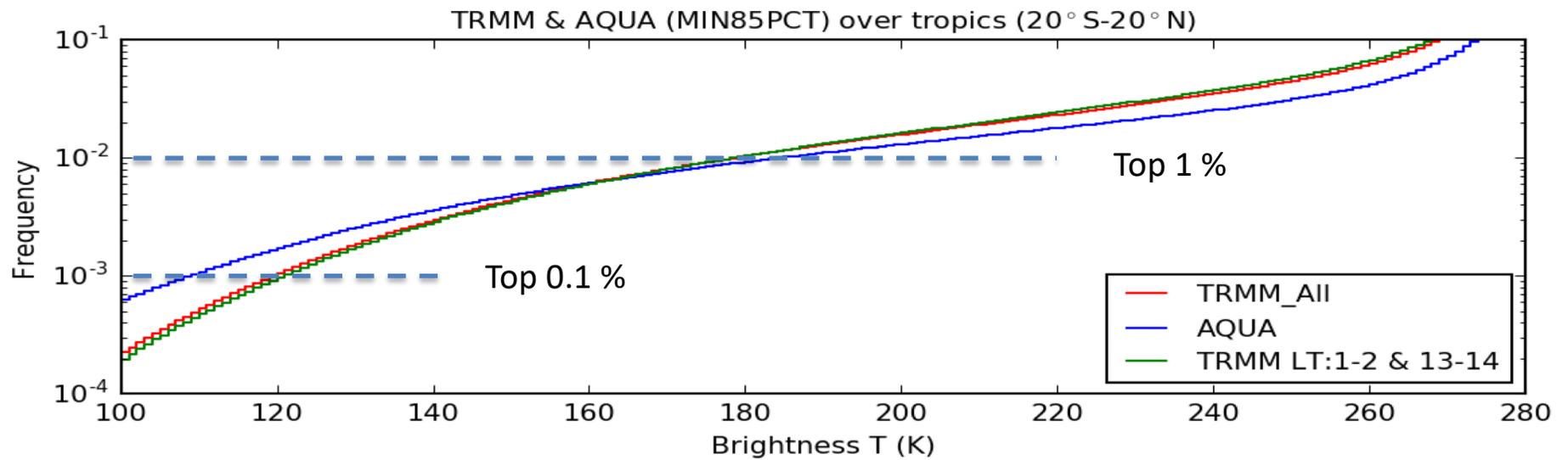
- **Beam filling due to resolution differences**
- **Sensitivity**
- **Different overpass local time**

Equator-Crossing Times (Local)

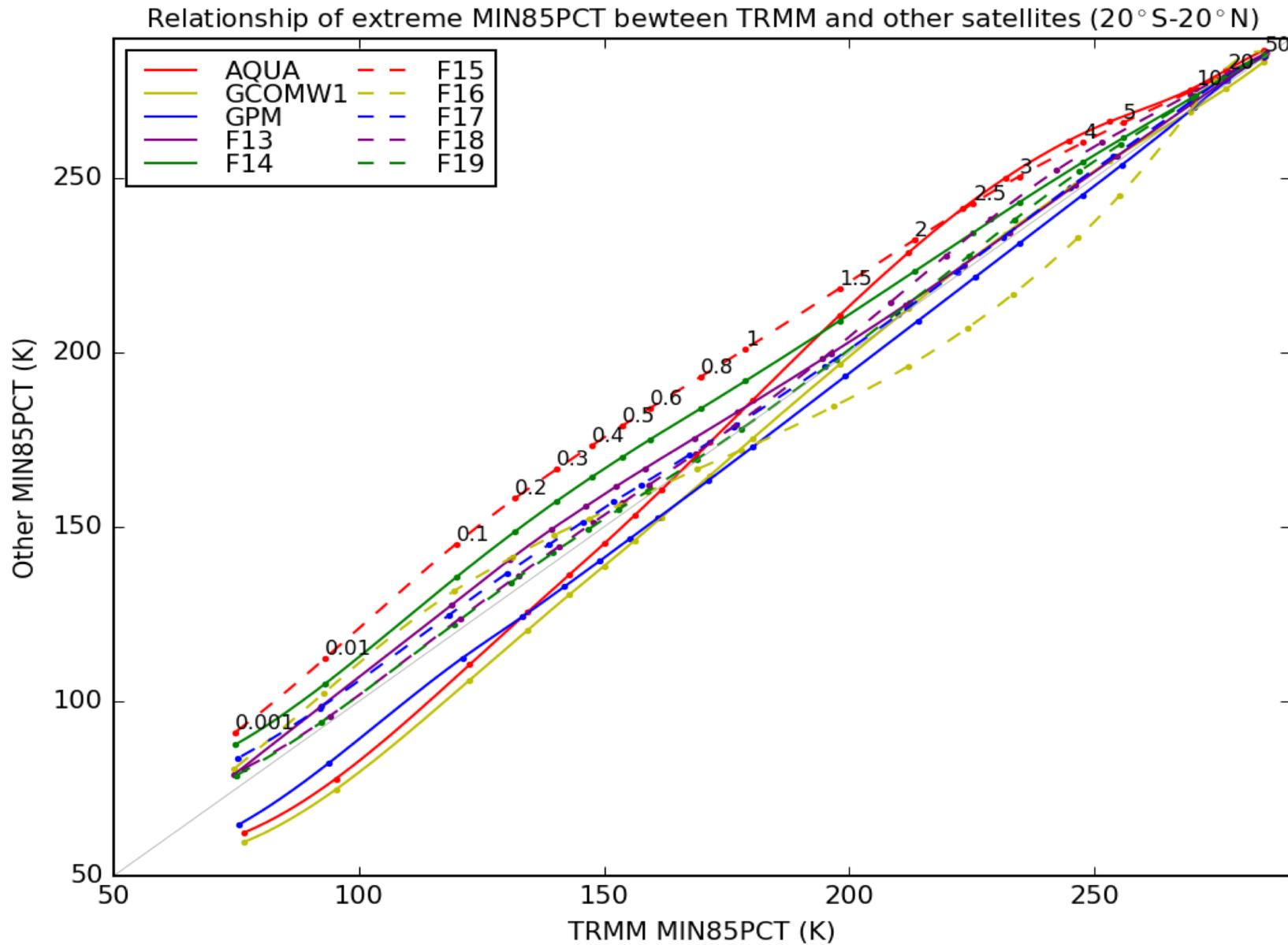


Ascending passes (F08 descending); satellites depicted above graph precess throughout the day.
 Image by Eric Nelkin (SSAI), 14 December 2017, NASA/Goddard Space Flight Center, Greenbelt, MD.

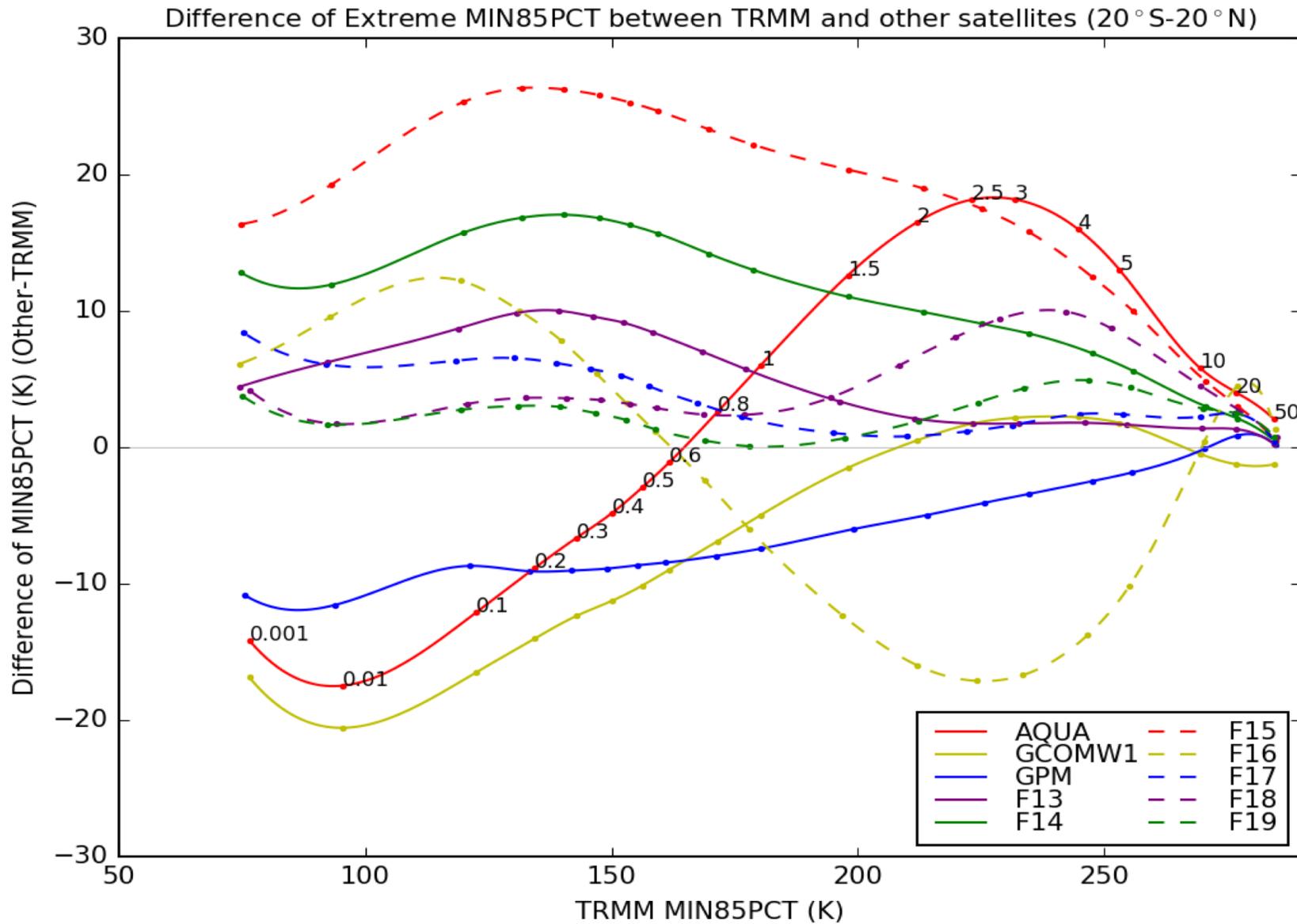
CDF of PF minimum 85/37 GHz PCT TMI vs. AMSR-E



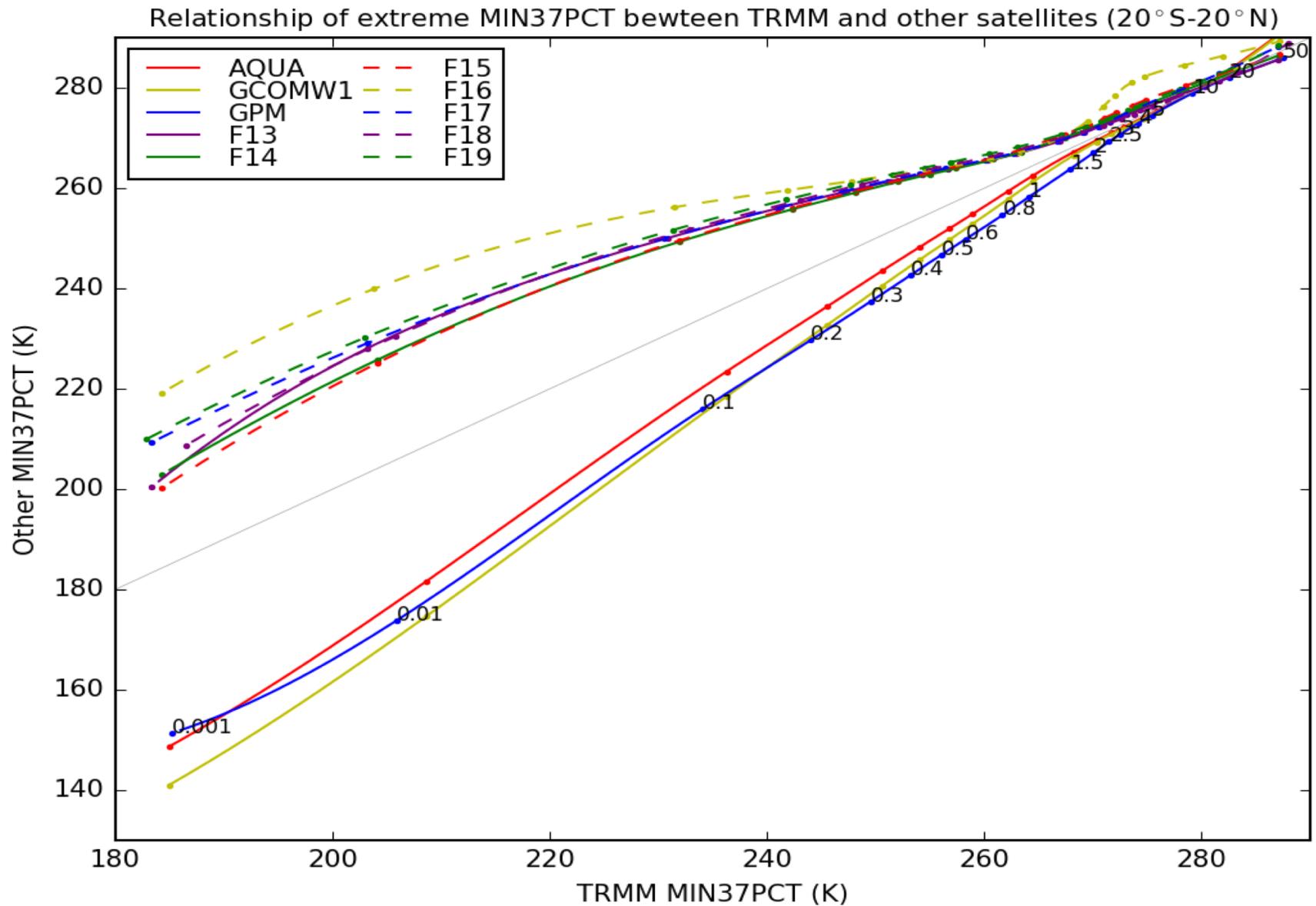
Inter-comparison of min 85 GHz PCT with the same rarity in intensity



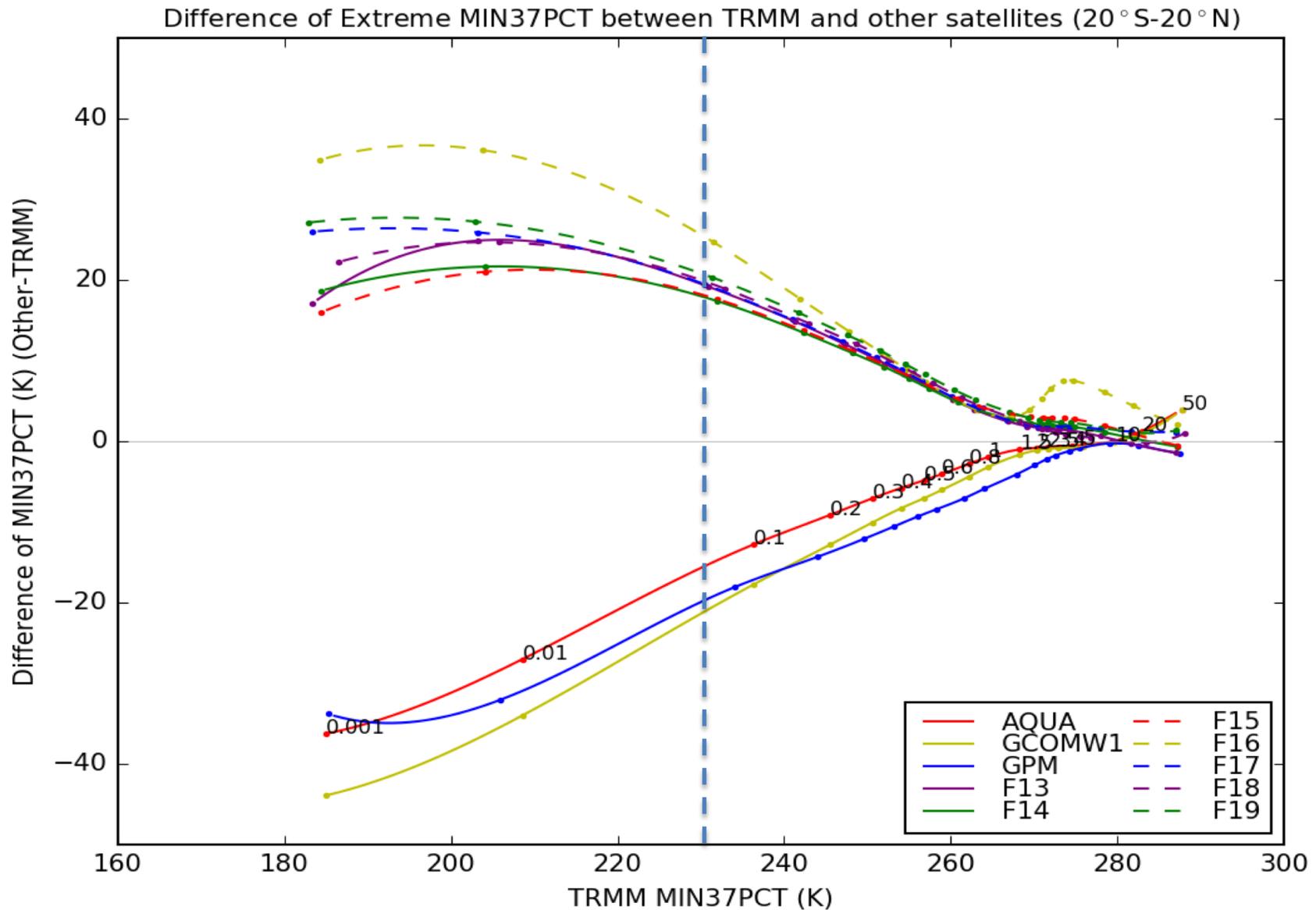
min 85 GHz PCT difference from TMI with the same rarity in intensity



Inter-comparison of min 37 GHz PCT with the same rarity in intensity



min 37 GHz PCT difference from TMI with the same rarity in intensity

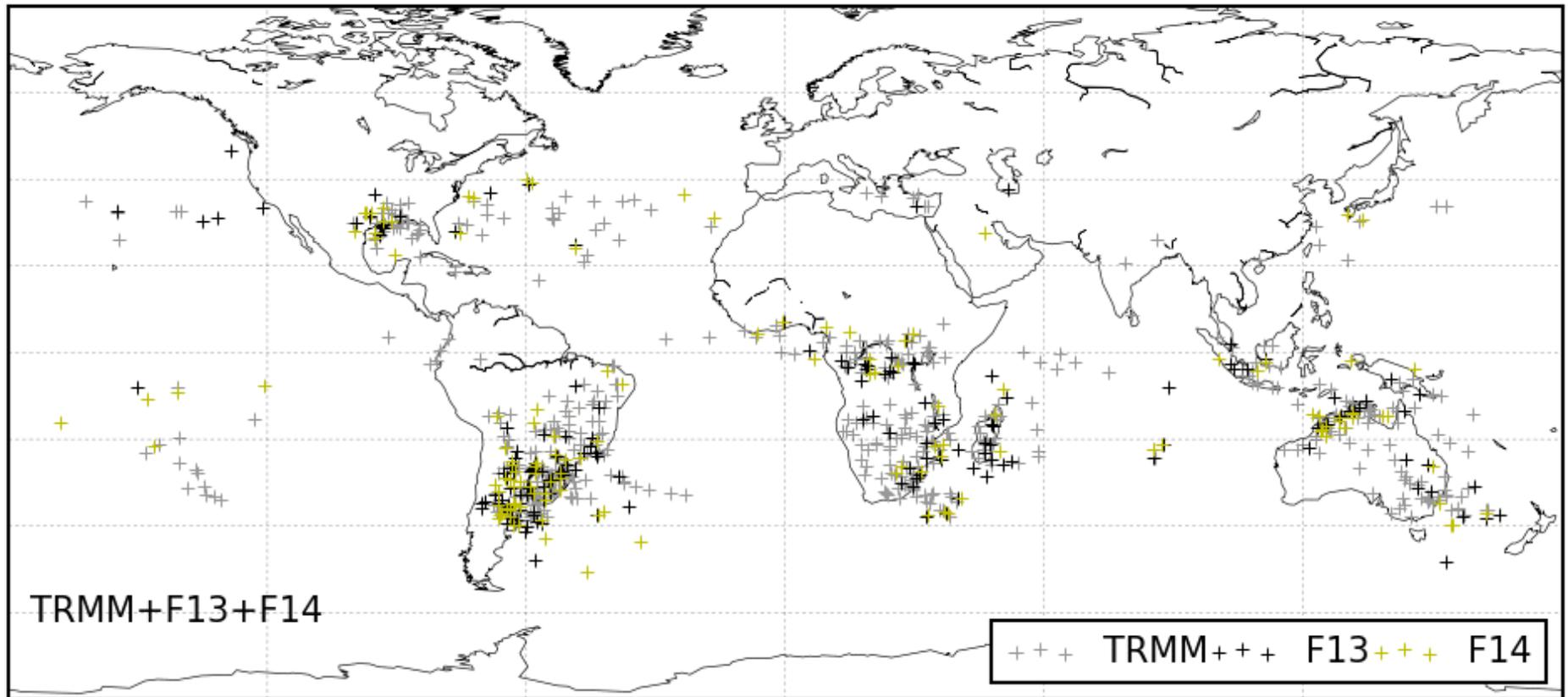


Thresholds of MIN37PCT and numbers of estimated hail PFs over tropics and globe

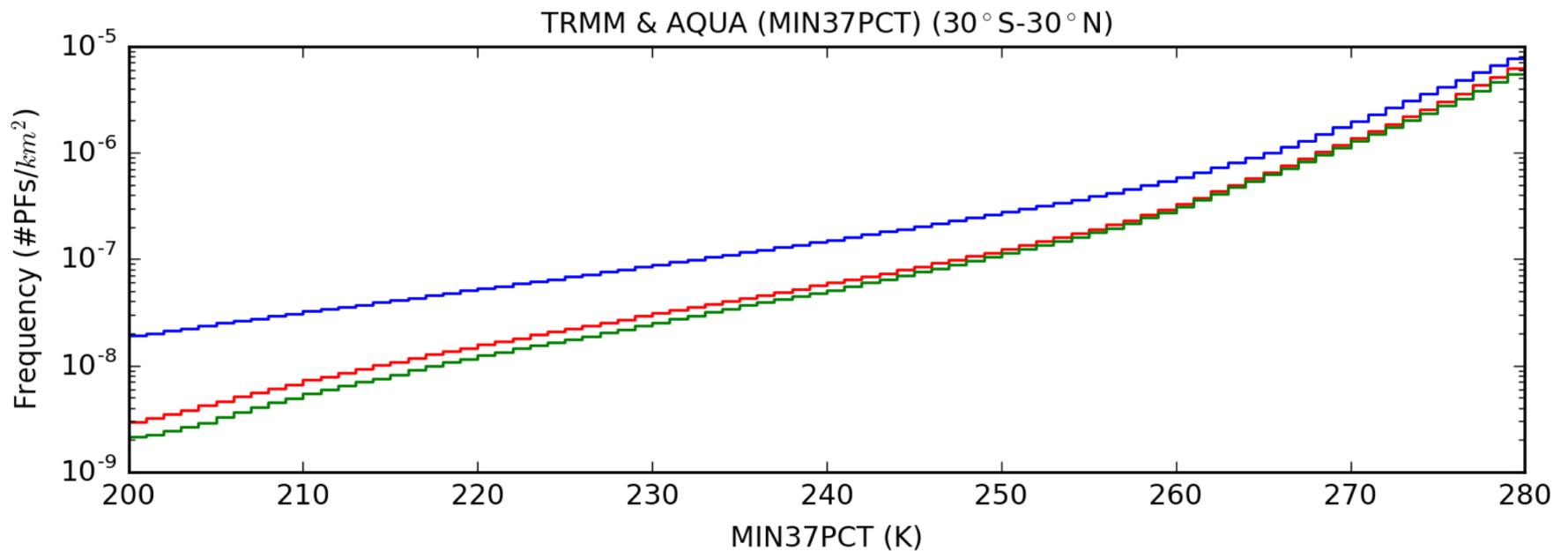
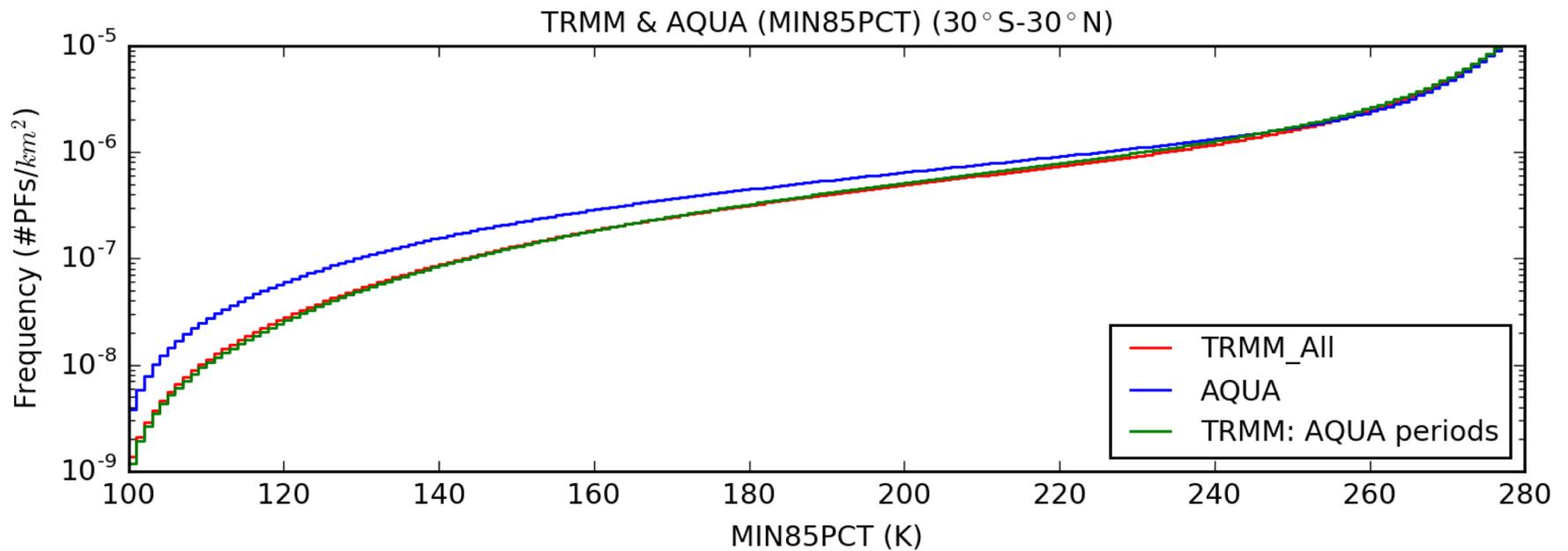
Satellites	MIN37PCT (K) & $T_{2m} > 10$ °C	# (20°S-20°N)	# (All domain)
TRMM	230.0	50477	99086
AQUA	214.3	31062	55614
GPM	210.1	8058	14692
GCOMW1	208.6	24368	42826
F13	249.5	16415	34986
F14	248.0	13734	28114
F15	248.2	7700	16426
F17	249.6	11687	22732
F18	250.0	7789	16795
F19	250.8	1645	3542

Hail PFs from all constellation satellites

199801 PFs possibly with hail from constellation satellites

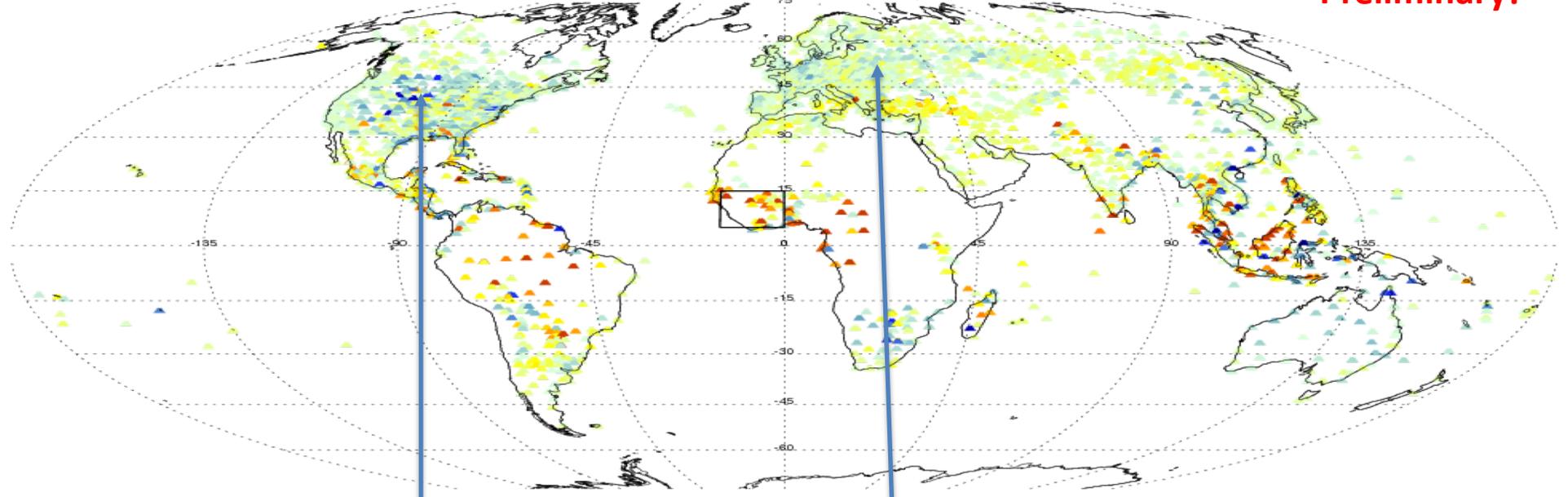


An alternative approach – event occurrence per sample area



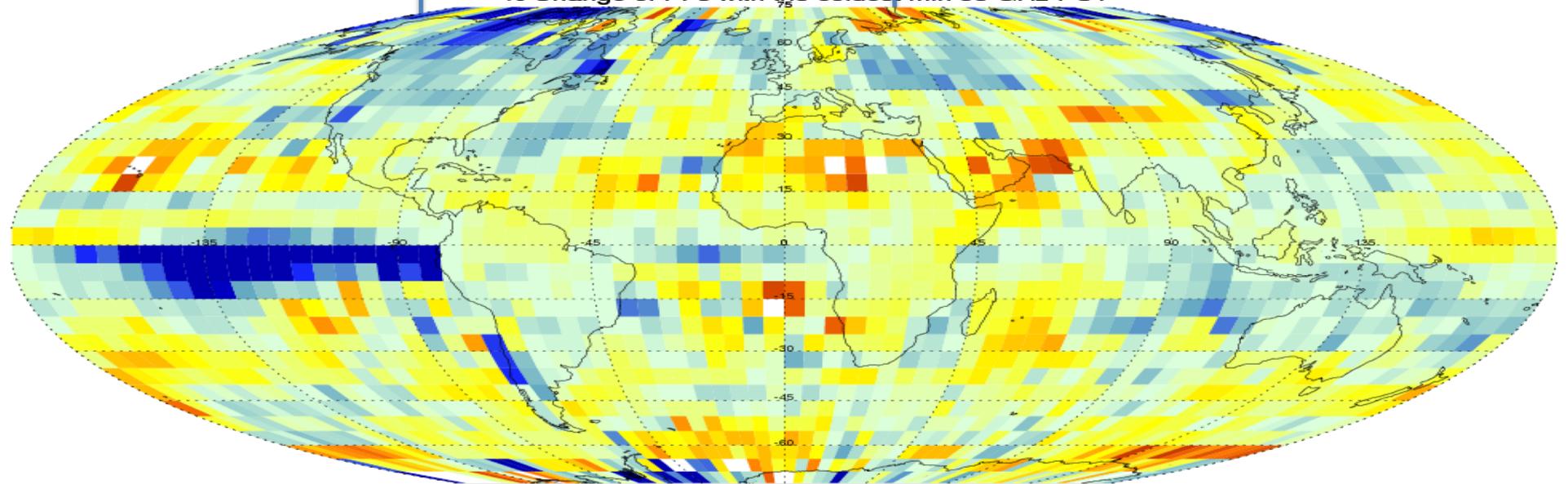
Preliminary!

Thunderday variations in 20 years (day/year)



3.0 -2.4 -1.8 -1.2 -0.6 0.0 0.6 1.2 1.8 2.4

% Change of PFs with the coldest min 85 GHz PCT



3.0 -2.4 -1.8 -1.2 -0.6 0.0 0.6 1.2 1.8 2.4

Summary

- New precipitation feature databases are created with 20 year GPROF and 1C brightness temperature products and are available to public at: <http://atmos.tamucc.edu/trmm/data/>
- Though passive microwave radiometers onboard constellation satellites have various sensitivity, resolution, and local overpass times, it is still possible to inter-compare the observations for the intense convection based on the rarity of these events.
- 20-year precipitation features from passive microwave observations provide a great opportunity to understand the variability of intense convection regionally and globally, and how intense convection change under recent climate variations. However, there is still a challenge to utilize PFs from different satellites together.